CLAIMS

What is claimed is:

1. A method of separating species signals in a composite magnetic resonance imaging signal comprising the steps of:

a) applying a series of steady-state free precession (balanced SSFP) pulse sequences,

b) measuring magnetic resonance signals during transient periods for the balanced SSFP sequences as steady-state signals evolve, and

c) fitting the transient response of the measured signals to a model to identify the smallest number of discrete exponential terms which provide a satisfactory representation of the measured data.

2. The method as defined by claim 1 wherein evolution of the steady-state in each balanced SSFP pulse sequence is purely exponential.

3. The method as defined by claim 2 wherein step c) utilizes a curve-fitting algorithm.

4. The method as defined by claim 3 wherein the curve-fitting algorithm utilizes non-negative least-squares.

5. The method as defined by claim 4 wherein the model in step c) is defined by:

$$M(t) = \sum_{i=1}^{N} C_i e^{-\frac{t}{\tau_i}} + M_{ss}$$

where $M(t)$ is the signal intensity as a function of time,

N is the number τ points used in the fit,

C_i is relative amount of material with an exponential term constant τ_i,

$M_s s$ is steady-state signal in a voxel, and

τ is the exponential term in the fitting model.

6. The method as defined by claim 4 wherein a single data frame is acquired repeatedly over decay of the magnetic resonance signals.

7. The method as defined by claim 6 wherein before step a) a plurality of preparation pulses are applied, wherein an inversion pulse is applied with the preparation pulses and magnetization starts at a negative value.

8. The method as defined by claim 6 wherein before step a) a plurality of preparation pulses are applied and magnetization is saturated thereby.

9. The method as defined by claim 6 wherein before step a) a plurality of preparation pulses are applied and magnetization starts in a steady state and is inverted in the steady state.

10. The method as defined by claim 4 wherein multiple data frames are acquired repeatedly over decay of the magnetic resonance signals.

11. The method as defined by claim 10 wherein before step a) a plurality of preparation pulses are applied, wherein an inversion pulse is applied with the preparation pulses and magnetization starts at a negative value.

12. The method as defined by claim 10 wherein before step a) a plurality of preparation pulses are applied and magnetization is saturated thereby.

13. The method as defined by claim 10 wherein before step a) a plurality of preparation pulses are applied and magnetization starts in a steady state and is inverted in the steady state.

14. The method as defined by claim 4 wherein before step a) a plurality of preparation pulses are applied, wherein an inversion pulse is applied with the preparation pulses and magnetization starts at a negative value.

15. The method as defined by claim 4 wherein before step a) a plurality of preparation pulses are applied and magnetization is saturated thereby.

16. The method as defined by claim 4 wherein before step a) a plurality of preparation pulses are applied and magnetization starts in a steady state and is inverted in the steady state.

17. The method as defined by claim 2 wherein the model in step c) is defined by:

$$M(t) = \sum_{i=1}^{N} C_i e^{-\frac{t}{\tau_i}} + M_{ss}$$

where $M(t)$ is the signal intensity as a function of time,

N is the number τ points used in the fit,

C_i is relative amount of material with an exponential term constant τ_i,

M_{ss} is steady-state signal in a voxel, and

τ is the exponential term in the fitting model.

18. The method as defined by claim 1 wherein before step a) a plurality of preparation pulses are applied, wherein an inversion pulse is applied with the preparation pulses and magnetization starts at a negative value.

19. The method as defined by claim 1 wherein before step a) a plurality of preparation pulses are applied and magnetization is saturated thereby.

20. The method as defined by claim 1 wherein before step a) a plurality of preparation pulses are applied and magnetization starts in a steady state and is inverted in the steady state.